

14. CLOSING REMARKS

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RESULTS

Important results of the NASA Acoustically Treated Nacelle Program are illustrated in figure 1. The noise reduction with nacelle treatment during landing approach is shown as a function of percent change in direct operating cost (DOC). The coordinates for the McDonnell Douglas design are 10.5 EPNdB at a 4.2 percent DOC increase and for the Boeing design 15.5 EPNdB at a 9.2 percent DOC increase. These direct operating cost increases are largely due to the costs of retrofitting the airplanes considered and are not applicable to other situations where treatment may be incorporated during original production.

The curve in figure 1 merely connects the two principal data points obtained in the program and thus applies to the conditions of the study, which include retrofit, the JT3D engine, the specific airplanes used, the weight conditions tested, and so forth. Perhaps under certain conditions the curve would be somewhat different, perhaps even discontinuous; nevertheless, this simplified figure illustrates two important points: (1) substantial noise reductions are possible, and (2) the direct operating costs increase with increasing noise reductions.

MAJOR ACCOMPLISHMENTS

In the course of getting these two very valuable coordinates, many other accomplishments resulted. Some of these accomplishments follow:

- (1) The noise reduction goals were met.
- (2) The achievement of the noise-reduction goals provides optimism that similar design procedures may be valid for other installations.
- (3) The successful estimate of flyover noise levels from engine ground tests provides optimism that flight tests will not always be required in future studies.
- (4) The many analyses and laboratory studies of acoustic lining material have advanced substantially the technology of treatment application to engine nacelles.
- (5) A number of metallic and nonmetallic materials have been identified as satisfactory, acoustically, for duct lining application, the choice depending largely on such factors as weight, strength, and cost.

(6) Valuable experience was gained which has improved the techniques of noise measurement.

(7) A successful ground test demonstration was made of a mechanized and controllable area inlet design which attenuates the emitted noise by fully or partially choking the entering flow.

(8) The subjective reaction studies have yet to be completed; however, it appears that much useful information will be forthcoming, including evaluation of effective perceived noise level (EPNL) and other parameters as noise annoyance indicators, and evaluation of the effectiveness of various test techniques involving juries.

REQUIRED ADDITIONAL MAINTENANCE STUDIES

Although the treated nacelles were successfully flight tested and although no maintenance-type problems were encountered, additional studies along this line would be required before a production type nacelle could be said to be available; these studies would include contamination of acoustic material during in-flight service, inservice life of acoustic material, and repairs and replacement of acoustic material.

CONTINUED RESEARCH

Although the two studies are approaching completion, Langley continues support of research in the area of jet aircraft noise alleviation. The attenuation of fan noise by means of acoustic treatment of the nacelle can be sufficiently effective so that the noise from the primary jet predominates, particularly during take-off. There is considerable interest, therefore, in attacking the primary jet noise, but no dramatic solution is yet in hand. The turbine and turbulence noise emitted from the engine in the primary jet may be amenable to acoustic treatment of the tailpipe and a study in this area is planned. The noise reduction potential of tailpipe treatment for the JT3D engine appears to be about 3 PNdB; however, probably more importantly the study will give us experience with acoustic treatment in the hot section of the engine.

CONCLUDING REMARKS

It should be kept in mind that despite the gains made by the McDonnell Douglas and Boeing studies in reducing noise, silent jet engines have not yet been attained. Rather, the present studies have indicated how only some of the airport community noise might be alleviated.

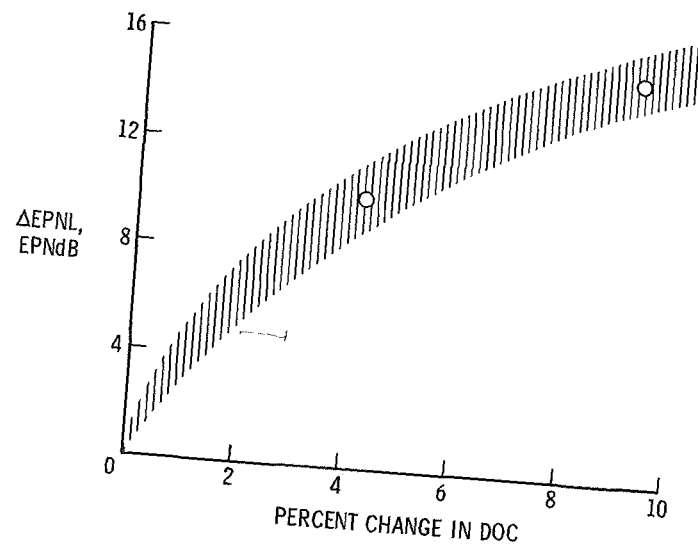


Figure 1.- Benefits and costs of retrofitted nacelles.

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